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OVERBURDEN ANALYSES AND STRIP-MINE CONDITIONS IN SOUTHEASTERN OHIO

BY

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CENTRAL STATES
FOREST EXPERIMENT STATION
Columbus 13, Ohio

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C O N T E N T S

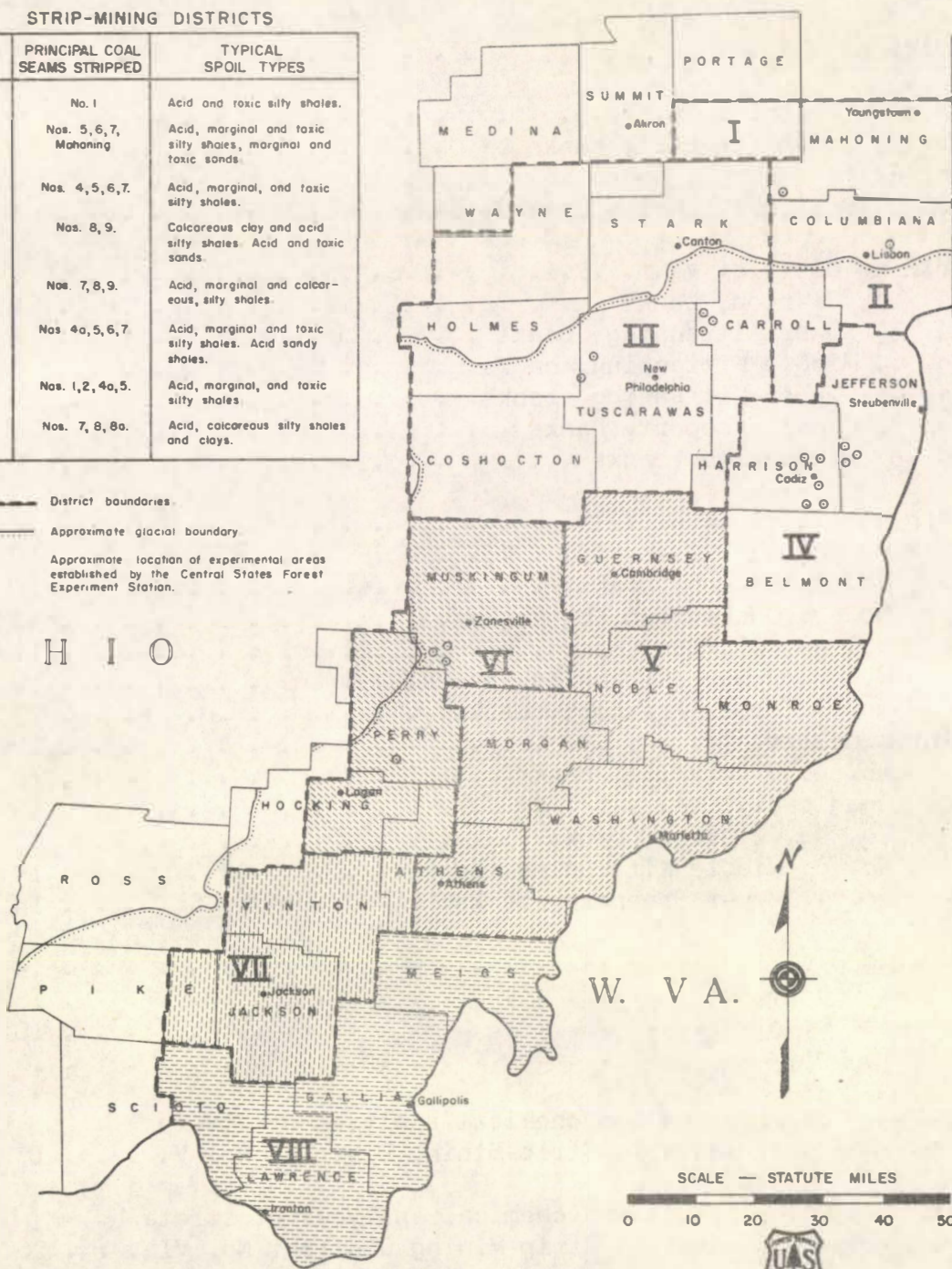
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STRIP-MINING DISTRICTS

DIST. NO.	PRINCIPAL COAL SEAMS STRIPPED	TYPICAL SPOIL TYPES
I	No. 1	Acid and toxic silty shales.
II	Nos. 5, 6, 7, Mahoning	Acid, marginal and toxic silty shales, marginal and toxic sands.
III	Nos. 4, 5, 6, 7.	Acid, marginal, and toxic silty shales.
IV	Nos. 8, 9.	Calcareous clay and acid silty shales. Acid and toxic sands.
V	Nos. 7, 8, 9.	Acid, marginal and calcareous, silty shales.
VI	Nos. 4a, 5, 6, 7.	Acid, marginal and toxic silty shales. Acid sandy shales.
VII	Nos. 1, 2, 4a, 5.	Acid, marginal, and toxic silty shales.
VIII	Nos. 7, 8, 8a.	Acid, calcareous silty shales and clays.

- District boundaries
- Approximate glacial boundary
- Approximate location of experimental areas established by the Central States Forest Experiment Station.

O H I O



Frontispiece--The coal-mining region of Ohio. Shaded areas on map indicate the location of strip-mining districts described in this report.

OVERBURDEN ANALYSES AND STRIP-MINE CONDITIONS

IN SOUTHEASTERN OHIO

by

G. A. Limstrom and R. W. Merz

INTRODUCTION

Conditions affecting reclamation measures for strip-mined lands in Ohio vary considerably with the coal seam removed and the locality. Each area requires a distinctive treatment, and the practitioner needs detailed information to help him choose the best possible uses for these lands. A basic classification of strip-mined lands for forest planting and a description of the factors to be considered in this classification have already been published.^{1/ 2/} A description of site conditions on specific areas may prove helpful in developing planting plans and may serve as an index of probable site conditions on future strippings for a given locality and coal seam.

The coal-mining region of Ohio has been subdivided into eight strip-mining districts (frontispiece). Although there is some overlapping of characteristics, bank conditions in each district are distinctive enough to make the district a convenient unit for detailed descriptions of strip-mine reclamation problems in the state. A reconnaissance of lands stripped for coal was made from 1945 to 1947. Each area was examined to determine bank texture, acidity, and other conditions affecting plant growth. A record of these conditions was made, and a map of the area was prepared. In addition, the high-walls next to most strippings were carefully examined and described stratigraphically. Samples of bank surfaces and of each stratum found in the high-walls were collected for laboratory analyses.

The main purpose of this report is to summarize these reconnaissance data for ready use by practitioners concerned with the conditions of stripped lands in southeastern Ohio. Another purpose of this report is to contribute to the general knowledge of Ohio

^{1/} G. A. Limstrom. Extent, character, and forestation possibilities of land stripped for coal in the Central States. Central States Forest Expt. Sta. Tech. Paper No. 109. December 1948.

^{2/} G. A. Limstrom and R. W. Merz. The rehabilitation of lands stripped for coal in Ohio. Central States Forest Expt. Sta. Tech. Paper No. 113. December 1949.

geology by permanently recording the stratigraphic data. Similar reports have already been published for strip-mining districts I, II, and III.^{3/ 4/ 5/}

Planting experiments to study the forestation aspects of strip-mine reclamation were started in southeastern Ohio in 1937.^{6/} Located on what is known as the Kehota tract in Perry County, these plantings are perhaps the earliest examples of systematic research on the rehabilitation of these lands in the nation. A number of commercially important trees were planted on the area, and now serve as good demonstrations of their comparative value (fig. 1).

Strip-mined lands in southeastern Ohio are generally acid, silty shales and loams, and usually contain a high proportion of sandstone. With few exceptions, the most practical use for these lands is growing trees to improve soil conditions and to produce forest products.

STRIP-MINING DISTRICT NO. V

This district includes part of Athens County and all of Guernsey, Monroe, Morgan, Noble, and Washington Counties (frontispiece). At the time of the reconnaissance there were less than 1,000 acres strip-mined for coal in the district. However, the area of strippable coal is extensive, and recently several large operations were started. The banks created to date are almost all silty, shaly loams in texture, and generally acid (table 1). A few were found to be calcareous and some so highly acid that they were classified as marginal insofar as reclamation possibilities are concerned. Marginal banks are those whose surfaces are toxic over 50 to 75 percent of their total area.

^{3/} G. A. Limstrom. Overburden analyses and strip-mine conditions in northeastern Ohio. Central States Forest Expt. Sta. Tech. Paper No. 114. January 1950.

^{4/} G. A. Limstrom. Overburden analyses and strip-mine conditions in mideastern Ohio. Central States Forest Expt. Sta. Tech. Paper No. 117. October 1950.

^{5/} G. A. Limstrom and R. W. Merz. Overburden analyses and strip-mine conditions in the northwestern district of the Ohio coal-mining region. Central States Forest Expt. Sta. Tech. Paper No. 124. July 1951.

^{6/} A. G. Chapman. Forest planting on strip-mined coal lands with special reference to Ohio. Central States Forest Expt. Sta. Tech. Paper No. 104. 1944.



Figure 1.--Part of experimental planting established in 1937 on lands stripped for the No. 6, Middle Kittanning, coal on the Kehota tract in Perry County, Ohio. This photograph, taken in 1944, shows the rapid development of a forest cover on lands of this kind in southeastern Ohio.

Table 1.--Area of strip-mined land in District No. V, Ohio, by county, acidity class, and coal seam, 1947

County	Acidity class and coal seam						Total
	Marginal		Acid		Calcareous		
	9	7	8	9	8	9	
----- Acres -----							
Athens	0	0	19	0	29	0	<u>1/</u> 48
Guernsey	0	240	45	0	0	0	285
Monroe	0	0	0	0	0	0	0
Morgan	0	0	42	33	0	0	75
Noble	6	0	7	235	0	28	276
Washington	0	0	0	8	0	0	8
Total	6	240	113	276	29	28	692

1/ Ames, Bern, and Canaan Townships only.

The coals strip-mined in the district are No. 7, Upper Freeport; No. 8, Pittsburgh; and the No. 9, Sewickley, or Meigs Creek. In some parts of the district No. 9 is known locally as No. 8a; it should not be confused with No. 8a, Redstone, coal, which is commercially important in Ohio only in Meigs, Lawrence, and Gallia Counties.

NO. 7, UPPER FREEPORT, BANKS

At the time of the survey, January 1947, the only stripping for No. 7, Upper Freeport, coal in the district was in Guernsey County. The overburden at one operation consisted mainly of massive sandstone, and silty, carbonaceous, pyritic shale. The banks at all locations were similar in physical composition but varied somewhat in acidity. Those near Byeville in Jackson Township and those in the southeastern part of Cambridge Township were composed mainly of soil and shale, with only a small proportion of sandstone; the pH was generally between 5.6 and 6.9. On stripped areas in Section 3 and 21 of Cambridge Township the acidity was somewhat lower, ranging from 4.0 to 5.5. In Center Township one large stripping more than 25 years old was well covered by natural vegetation and forest plantings, the pH range was also from 4.0 to 5.5, and the materials had weathered to a shaly, sandy loam.

NO. 8, PITTSBURGH, BANKS

A number of strippings for No. 8, Pittsburgh, coal were found in Athens, Guernsey, Morgan, and Noble Counties. However, they are small compared with operations for this coal in District IV (Belmont, Harrison, and Jefferson Counties).

In the part of Athens County located in District No. V, the only stripping found was for No. 8, Pittsburgh, coal. At the time of the reconnaissance only 48 acres had been stripped. As elsewhere in the state, conditions varied according to the character of the overburden removed in the operation.

In Section 30, Ames Township, one area less than a year old was found to be a calcareous, stony silt-loam. An additional year's weathering would no doubt have placed these banks in excellent condition for planting. Although the Redstone and Fishpot limestones were not present in massive form, nodular limestone and calcareous shales were found where these members are due (page 19). The Upper Pittsburgh sandstone also occurred in this locality, a few feet above the coal. The combination of sandstone and nodular limestone with calcareous shales and clays, when mixed in the stripping operation, make ideal conditions for plant growth.

In Section 28 of Bern Township, however, the banks derived from strip-mining of No. 8 coal were an acid, shaly loam. The pH range was generally from 4.0 to 5.5. About 20 percent of the area was covered with toxic material--waste coal and clay from an adjacent underground operation. Except for an occasional thin bank of extremely hard limestone, no calcareous material was found in the overburden (page 20).

A small stripping for No. 8 coal was found in Section 25 of Canaan Township. The resulting banks were classified as an acid, stony, sandy loam, and the pH range over 75 percent of the area was from 4.0 to 6.9; the remaining area was toxic. No calcareous material was found in the high-wall. Three feet of highly acid shale lay directly over the coal (page 21).

Only two strippings for No. 8, Pittsburgh, coal were found in Guernsey County. One, 33 acres in extent, was located in Sections 8 and 9 of Oxford Township, and the other, 12 acres in extent, was located in Section 7 of Washington Township. The overburden at the high-wall examined contained little or no limestone (page 22), and the resulting banks were classified as sandy shales or shaly clay-loams. Acidity ranged from a pH of 4.0 to 6.9. The banks in Sections 8 and 9 of Oxford Township--a current operation--contained less than 20 percent soil, less than 10 percent limestone, and about 70 percent shale. The stripped area in Section 7 of Washington Township--a shallow digging--was composed almost entirely of soil.

In Morgan County only 42 acres of No. 8 banks were found. As in the case of adjoining counties, little or no limestone was noted in the strata over the No. 8 coal. The overburden consisted mainly of fragmental and massive sandstone, sandy and micaceous shale, and soft, silty, carbonaceous shale (page 23). In the one high-wall examined a highly acid clay parting was noted in the coal seam; the coal above this parting was sometimes of poor quality and contained a high proportion of pyritic material. Where this low-quality coal and clay parting was placed on the top of the banks, the surfaces were found to be toxic and nonplantable. In other locations on the same stripping the surfaces were an acid, shaly, sandy loam and the pH generally ranged from 4.0 to 5.5.

One stripping for No. 8 coal was located in Noble County. Only 7 acres in extent, this area was located in a creek bed in Section 19 of Elk Township. The overburden consisted mainly of shaly alluvial material and may not be typical of future hillside stripping for this coal. The pH ranged from 4.0 to 5.5 over 70 percent of the area; the rest was toxic.

NO. 9, SEWICKLEY (MEIGS CREEK), BANKS

Strip-mined areas resulting from mining this coal seam in the district were found in Morgan, Noble, and Washington Counties. Stripping for the No. 9 seam in Morgan County was found only in areas with shallow coal deposits; the banks, therefore, may not be typical of future larger operations with moderate to thick overburdens. The areas examined were located in Section 4 of Center Township and Sections 30 and 31 of Manchester Township. Banks in both areas were shaly clay-loams, with pH ranges from 4.0 to 6.9 and a considerable amount of soil-sized particles.

In Noble County, 269 acres of No. 9 banks were found. They were classified as acid, silty shales and loams. The strata over the No. 9 coal in this county were found to be extremely variable; the overburden at some operations consisted only of 3 or 4 strata, while on others there were as many as 12 (pages 24 and 25). Those operations where the overburden consisted only of a few strata were shallow excavations, and may not be representative of future, more extensive mining in the same locality.

The most extensive stripping in Noble County was located in Brookfield Township, where No. 9 coal was being mined. Except for a few areas where toxic material had been placed on the surfaces, the banks were fair planting sites. They varied in texture from coarse sandy to silty shale-loams; acidity was usually in the 4.0 to 5.5 pH range. No limestone was found in the high-walls examined in this township.^{7/}

In Sections 14 and 15 of Jackson Township one 28-acre stripping was found to be calcareous. The surface was classed as a shaly clay-loam and was considered a good planting site. The overburden contained a small amount of limestone and other calcareous strata (page 25).

A 6-acre bank in Section 6 of Jefferson Township, Noble County, was found to be marginal and largely nonplantable. A considerable amount of low-quality waste coal had been placed on the surface. The pH over more than 70 percent of the area was below 4.0.

Strip-mining was just beginning in Washington County at the time of the reconnaissance. Only 8 acres of stripping for No. 9 coal--in Section 18, Aurelius Township--was found. The banks were composed almost entirely of soil and were acid in chemical reaction.

^{7/} Since the reconnaissance of strip-mined lands in this county, a number of deeper cuts have been made. Limestone has been found in high-walls near recent operations, and the new banks in these locations are often calcareous.

It is difficult to predict the nature of lands that may result from future strippings from the shallow digging observed to date.

STRIP-MINING DISTRICT NO. VI

District No. VI includes all stripping in Hocking, Muskingum, and Perry Counties, and Dover, Trimble, and York Townships in Athens County. The stripped lands were generally acid, silty shale-loams and clays (table 2). A few toxic and sandy banks occurred in scattered areas over the district; no calcareous surfaces were found. The principal coals being stripped are No. 5, Lower Kittanning; No. 6, Middle Kittanning; and No. 7, Upper Freeport. No. 4a, Clarion, coal is being stripped rather extensively in a restricted area in southern Hocking County, near the Vinton County line. One small stripping for No. 8, Pittsburgh, coal was found in Union Township, Muskingum County. There is also a small amount of stripping for No. 6a, Upper Kittanning, coal in Athens County.

Table 2.--Area of strip-mined lands in District No. VI by texture, acidity, class, coal seam, and county, 1946

Texture	Acidity	Coal:	County			
		seam:				
		No.:	Athens ^{1/}	Hocking	Muskingum	Perry
		----- Acres -----				
Sands	Marginal	6	--	8	--	--
		7	193	--	--	--
	Acid (pH 4.0-5.5)	6	49	68	--	47
		7	18	--	--	--
Silty shales	Acid (pH 5.6-6.9)	7	--	29	--	--
	Toxic	4a	--	166	--	--
	Acid (pH 4.0-5.5)	6	--	--	--	172
		5	--	--	--	38
		6	28	--	1156	281
		6a	32	--	--	--
	Acid (pH 5.6-6.9)	7	48	--	117	389
		6	9	102	--	181
		7	72	--	--	--
		8	--	--	11	--
Clays	Toxic	6	--	--	--	153
	Marginal	6	--	--	--	47
	Acid (pH 4.0-5.5)	5	--	--	--	605
		6	--	--	--	349
		7	88	--	--	67
	Acid (pH 5.6-6.9)	6	--	212	--	869
		Totals		537	585	1284

^{1/} Dover, Trimble, and York Townships only.

NO. 4a, CLARION, BANKS

Stripping for No. 4a, Clarion, coal in the district was found only in the vicinity of Mt. Pleasant, Washington Township, in Hocking County. The overburden was similar to that found on the more extensive operations in Vinton County (pages 50 to 52). The most important local characteristic of the overburden is a toxic layer of black, fissile, carbonaceous shale directly over the coal seam. The resulting banks were composed, roughly, of 35 percent soil, 20 percent sandstone, and 45 percent of the black shale; most of the surfaces were highly toxic, especially where the black shale was placed on the bank surfaces. Some grading of the spoils was in progress at the time of inspection, but acidity conditions were worsened rather than improved by this operation. These banks may remain unplantable for a number of years.

NO. 5, LOWER KITTANNING, BANKS

Strip-mining for No. 5 coal in the district was found only in Clayton Township of Perry County. The overburden consisted mainly of massive sandstone and clay (page 27), and the banks were generally acid, sandy clays. The acidity range was usually from pH 4.0 to 5.5; scattered toxic patches appeared to be due to the highly acid shale lying directly over the coal being placed on the surface of the banks.

NO. 6, MIDDLE KITTANNING, BANKS

Much of the strip-mining in the district was for No. 6, Middle Kittanning, coal. Most of the resulting banks were plantable, but there was a wide variation in texture and acidity. The overburden was usually composed of silty, sandy and clayey shales, clay, and massive sandstone (pages 28 to 31). This complex overburden and the large number of operators using different methods of mining account for the wide variation in bank conditions. No. 6 coal usually occurred in two or three minable benches, and the intervening partings were composed of highly acid, pyritic shales and clays. These partings and the shale occurring directly over the coal were the cause of the highly acid banks that occurred in scattered locations throughout the district. Most of the No. 6 banks in Athens, Hocking, and Perry Counties were acid, silty shales and clays, with acidity ranging from pH 3.0 to 6.9. In Muskingum County the pH range was generally from 3.0 to 5.5. Except for the toxic and marginal areas, these areas offer good site conditions for growing a wide variety of conifers and hardwoods.

NO. 6a, UPPER KITTANNING, BANKS

Only two small areas stripped for No. 6a, Upper Kittanning, coal were found in the district; these were located in Section 16, York Township in Athens County. The two adjacent high-walls were quite variable in composition, but both included some micaceous sandstone, and in one some hard ferruginous limestone or ironstone nodules were found (pages 32 and 33). These may serve as good identifying features. Most of the stripped area was a sandy, shaly loam, ranging in acidity from pH 4.0 to 5.5. High acidity comes from the black, carbonaceous, clay shale located directly over the coal seam. No extensive stripping for this coal is likely.

NO. 7, UPPER FREEPORT, BANKS

Some stripping for No. 7 coal was found in all counties of the district. However, most of these strippings were located in Athens County. The overburden was typically shale and sandstone, with considerable variation in the acidity of these strata by localities (pages 34 to 37). One representative high-wall in Section 2, York Township, south of U. S. Highway No. 33 in Athens County, was found to have 5 feet of black, carbonaceous shale directly over the No. 7 coal. The pH of this shale was as low as 3.0, and all No. 7 banks in this locality were found to be highly acid. North of this highway in Athens, Hocking, and Perry Counties, none of the high-walls adjacent to No. 7 strippings were found to have this thick layer of toxic shale. As a result, the banks are nearly all plantable, ranging in acidity from pH 4.0 to 6.9.

The banks resulting from the mining of No. 7 coal in the district were generally stony, sandy loams or sands. In Section 19, Monroe Township, Perry County, where no sandstone was found in the high-wall, they were a shaly, silty clay. Except for some of the strippings located south of U. S. Highway No. 33 in Athens County, most of the No. 7 banks are good planting sites for both conifers and hardwoods.

NO. 8, PITTSBURGH, BANKS

Only one stripping, 11 acres in area, stripped for the No. 8 coal was found in the district. This was located in Sections 12 and 13, Union Township, Muskingum County, in the western periphery of the No. 8 coal field. The stripped areas were acid, shaly, silt loams, with pH ranges generally from 5.6 to 6.9. Surface material consisted mainly of soil-sized particles, shale, and scattered limestone fragments.

STRIP-MINING DISTRICT NO. VII

At the time the survey was made, all stripping for coal in the district was found in Jackson and Vinton Counties. No strip-mining exclusively for coal was found in those parts of Athens and Pike Counties included in the district. Although the total stripped area in the district was estimated at less than 1500 acres, as many as eight different coal seams had been mined by this method (table 3).

Table 3.--Area of land stripped for coal in District No. VII, by coal seam, texture, acidity class, and county, 1946

Coal seam	Texture	Acidity Class	County	
			Jackson	Vinton
			Acres	
1	Loam	Acid	12	--
		Calcareous	14	--
2	Loam	Acid	36	--
4	Loam	Acid	--	14
Ogan	Loam	Acid	--	8
4a	Sand	Marginal	--	57
	Loam	Marginal	--	59
		Acid	--	238
		Calcareous	--	13
	Clay	Marginal	19	--
		Acid	31	--
5	Loam	Acid	42	--
	Clay	Acid	85	--
6	Loam	Acid	--	156
7	Loam	Toxic	121	--
		Acid	--	207
Totals			360	752

JACKSON COUNTY

The reconnaissance of strip-mined lands in Jackson County was made in September 1946. At that time an estimated 360 acres had been stripped. Five different seams of coal had been mined, and the resulting banks differed considerably.

No. 1, Sharon, Banks

Stripping for this coal was found only in Sections 15 and 21 of Liberty Township. The resulting banks were in excellent

condition for plant growth as most of the overburden was composed of calcareous, silty shales mixed with small quantities of acidic sand, sandstone, and clay (page 39). Where the shales predominated, the surfaces had a pH of 7.0 to 7.5 and were loose, well-aerated shaly loams. Where the sandstone was predominant, the range in pH was from 5.6 to 6.9. Both surfaces were being rapidly invaded by the native pines, yellow poplar, red maple, sassafras, aspen, and red oak.

In addition to the calcareous shale found in the overburden, a 1-foot layer of clay directly over the coal contained two partings which may prove to be a good identifying characteristic. The parting in the upper portion of this clay layer was a narrow (1/2-inch) band of calcareous sandstone; in the middle of the clay layer was a 2-inch band of coal.

No. 2, Quakertown, Banks

Only one large area resulting from the mining of No. 2 coal was found; this was a 36-acre stripping in Section 31, T. 9 N., in Milton Township. The banks were generally a shaly, sandy loam, with pH ranging from 5.6 to 7.0. There was an excellent natural stand of sycamore over almost the entire area. One sample plot taken in the stand had a density of 1500 to 3500 trees per acre; the average age was 12 years, and the dominants measured 25 feet in height and 2 to 3 inches in diameter at breast height.

Water impounded in the final cut prevented a complete analysis of the overburden. The exposed portion of the high-wall was composed of about 20 feet of calcareous shale, 8 feet of massive sandstone, and about 4 feet of soil and subsoil (page 40).

No. 4a, Clarion, Banks

Strip-mining for No. 4a, Clarion, coal was quite extensive in Madison and Milton Townships of Jackson County. The overburden was composed mainly of massive sandstone and a clayey, ferruginous shale (pages 41 and 42). The Vanport limestone, generally less than 1 foot thick, lay within 3 feet above the Clarion coal; it was very hard, somewhat massive, and intermixed with iron carbonates. Weathering of this limestone was so slow that it had little effect on the acidity of associated materials on the mined areas.

The resulting banks were shaly clays and loams. In Madison Township the acidity of the 4a banks was generally in the 4.0 to 5.5 pH range. In Milton Township 50 to 75 percent of the surfaces were toxic and therefore not plantable. Toxic conditions were due mainly to the practice of placing waste coal on surfaces of banks.

No. 5, Lower Kittanning, Banks

No. 5, Lower Kittanning, coal had been strip-mined in a number of locations in Franklin, Jefferson, and Madison Townships of Jackson County. The overburden consisted mainly of soft, massive sandstone; ferruginous, plastic clay; silty shales, and clay shales (pages 43 to 46). Laboratory analyses of one high-wall section showed the pH to be less than 5.2 for all strata overlying the coal.

The Hamden formation, usually found over No. 5 coal and considered a good means for identifying this seam in Ohio, was not easily recognized in Jackson County. If present in the county, it contains little or no red kidney ores and nodular limestone so typical of this formation in the more northerly parts of the state.

The banks were generally acid, shaly loams and clays; only a few toxic areas were found. The acidity was generally between a pH 4.0 and 6.9. One stripped area in Section 2 of Jefferson Township supported a well-stocked natural stand of sycamore 10 to 15 feet in height and of good form.

No. 7, Upper Freeport, Banks

No. 7, Upper Freeport, coal was being strip-mined extensively in Sections 13 and 24 of Milton Township in Jackson County. The overburden consisted mainly of soft, massive sandstone, thin-bedded silty shales, and a very hard ore about 3 feet thick (page 47). The 1-foot layer of fissile shale, or roof coal, was found to be highly acid.

The banks were classified as toxic and nonplantable. This condition was due to the fact that the roof coal had been placed on the surfaces of most of the banks. Small areas not covered with coal were being rapidly revegetated by weeds and trees.

VINTON COUNTY

Five different coal seams have been mined by stripping methods in the county and, as a result, a variety of conditions exist. All banks examined contained enough "soil" for plant growth, but about one-third of the total area was found to be too acid, or toxic, to support any vegetation. In this county the nonplantable areas were due largely to the practice of placing the unused roof coal and coal partings on the surfaces of banks, and of using banks as temporary storage locations for coal to be transported at a later date.

One of the most toxic banks was found along U. S. Highway No. 50 southwest of Prattsville in Madison Township. The area was probably stripped principally for the clay lying just below the 4a, Clarion, coal as the coal here was of such poor quality that most of it was discarded and thrown on the top of the banks. The "soil" was actually a black, sandy, toxic, coal, and was supporting little or no vegetation.

As a whole, however, the banks in the county were suitable for forest planting. Acidity ranges were generally from pH 4 to 5.5 with smaller areas from 5.6 to 6.9. A number of areas were actually calcareous; they were found chiefly on the No. 4 and 4a spoils that contain a small amount of limestone or calcareous shale.

No. 4, Brookville, Banks

This seam is known locally as Newland coal, and only one area was found where it was being stripped. In the northern counties this coal is usually overlain directly by 3 to 4 feet of limestone (Putnam Hill), but here the limestone was absent and replaced by 14 feet of calcareous, clayey, thick-bedded shale (page 48). As a result, the banks formed were calcareous and in excellent physical condition for plant growth.

Ogan Banks

The Ogan seam is also known locally as Flint coal. It can be identified by a bed of gray to black calcareous ores lying just over or less than 1 foot above the coal (page 49). Only one area stripped for this coal was found, and as the coal is found in merchantable quantities only in one small area, not much stripping is expected. The banks resulting from the mining of this coal were plantable, with a high proportion of soil and acidity ranging generally from 4 to 5.5.

No. 4a, Clarion, Banks

The 4a, Clarion, seam was being stripped extensively in the county, along with the underlying clay. This seam can usually be identified by the presence of the Vanport limestone and associated ores in the overburden (pages 50 to 52). The limestone is gray, very hard, fossiliferous, and sometimes ferriferous. In the southern part of the county, near Clarion, it is massive and lies almost directly over the coal; at Oreton it is about 10 feet above the coal and is represented only by boulders; near McArthur the member is 10 to 13 feet above the coal and composed entirely of ores.

In the northern part of the county it was not found in the overburden, where cuts as deep as 20 to 25 feet were being made.

The overburden was composed mainly of acid silty shales and a massive sandstone which is poorly bonded and breaks down to sand easily in the stripping operation. In the northern part of Swan Township the coal was often overlain directly by a black, fissile, carbonaceous shale. Where the unused coal, coal partings, and carbonaceous shale were not placed on the surfaces, the banks resulting from the mining of this coal were in good condition for planting one to two years after stripping.

No. 6, Middle Kittanning, Banks

This coal was being stripped extensively in Clinton Township. The overburden consisted mainly of acidic, silty shales, with some sandy shales, sandstone, and clays (page 53). No reliable distinguishing feature was found in the overburden, except possibly the presence of iron concretions, nodular limestone, and calcareous ores mixed in the 8 feet of non-fossiliferous shale directly over the coal. These ores and nodules are also often found over the No. 5 coal, but intermixed with shales which are fossiliferous. The coal bed itself is however a good distinguishing feature, as it is nearly always represented by two or sometimes three separate coal benches, separated by highly acidic clay partings.

Where coal was not dumped on the surfaces, these banks, with a high proportion of soil and acidity ranges from a pH of 4 to 5.5, offered good possibilities for tree growth.

No. 7, Upper Freeport, Banks

No. 7, Upper Freeport, coal was being stripped extensively in Wilkesville Township. The overburden was mainly sandy and silty shales, with some sandstone and clay. The sandstone and shales were highly ferruginous, and when exposed to weathering were a mottled red and orange. Some of the banks were quite acid but on the whole were plantable a few years after stripping. The acidity in this case appeared to be due to the pyritic material in the shales occurring directly over the coal (pages 54 and 55).

STRIP-MINING DISTRICT NO. VIII

The area of strip-mining for coal in this district is relatively small (table 4). The district includes all of Gallia, Lawrence, and Meigs Counties and the eastern half of Scioto County.

Table 4.--Area of land stripped for coal in District No. VIII, by coal seam, texture, acidity class, and county, 1946

Coal seam	Texture	Acidity Class	County		
			Gallia	Lawrence	Meigs
			- - - - -Acres- - - - -		
7	Loam	Acid	5	--	--
8	Loam	Calcareous	23	--	--
	Clay	Calcareous	--	--	43
8a	Loam	Acid	--	32	8
		Marginal	--	--	4
Totals			28	32	55

GALLIA COUNTY

Only two strip-mined areas were found in this county (September 1946). One area of 5 acres resulted from the mining of No. 7, Upper Freeport, coal; the other, 23 acres, resulted from stripping for No. 8, Pittsburgh, coal.

The No. 7 banks in Section 19 of Walnut Township were classified as an acid, sandy loam to sandy clay. The pH range for more than 90 percent of the area was from 4.0 to 5.5; the remainder was toxic. Toxicity was due to the highly acid clay shale directly over the coal (page 57). Most of the overburden, however, was composed of massive sandstone and sand.

The No. 8 banks found in Section 12, Guyan Township, were classified as calcareous, stony silt-loams. About 25 percent of the surface, however, was covered with coal, which has made part of the area toxic and unplantable. The areas not covered with coal were being invaded by sycamore, black locust, sumac, ailanthus, and red elm to such an extent that planting may not be necessary.

The overburden was predominantly calcareous shale and sandstone (page 58). The toxic conditions on the banks appear to come only from the coal and coal partings.

LAWRENCE COUNTY

Strip-mining exclusively for coal was found in Lawrence County only in the "Greasy Ridge" area in Mason Township. The coal removed is believed to be the No. 8a, Pomeroy, seam. The overburden was made up mainly of sandstone and silty shales. Within 2 feet of the coal there were narrow alternate bands of hard sandstone and

shale, both highly acid (page 59). The banks were sandy, stony, silt-loams, and the pH was generally between 4.0 and 5.5, with occasional patches below 4.0.

The relief of Lawrence County is so great that many coal outcrops occur, including the 4a, 5, 7, 8, and 8a seams. Some of these may be thick enough to mine commercially. Coal is sometimes recovered in connection with clay quarrying in the county.

MEIGS COUNTY

No. 8, Pittsburgh, and No. 8a, Pomeroy, coals have been strip-mined in Meigs County. Only one stripping for No. 8 coal was found, located in Section 29 of Bedford Township. Strata over this coal seam was chiefly clay and some shale mixed with limestone boulders (page 60). The spoils were generally a calcareous, stony, sandy clay. The proportion of clay was so high that compact, impervious surfaces may develop. About 25 percent of the surfaces was covered with roof coal and was therefore toxic and nonplantable.

Stripping for 8a, Pomeroy, coal was found in Sections 16 and 27 of Salisbury Township. Here, as in Lawrence County, the overburden was composed mainly of soft sandstone and silty and clayey shales. In both counties the narrow band of sandstone 10 to 20 feet below the thick massive sandstone was found to be highly acid (page 61). The banks were sandy to sandy clay loam in texture, and except for areas which were covered with roof coal and coal partings, the acidity was favorable for plant growth, ranging from a pH of 5.6 to 6.9. About half of the bank surfaces in Section 16 were covered with roof coal; these surfaces were toxic and nonplantable.

APPENDIX I

Descriptions and chemical analyses of strata overlying coal seams in Strip-Mining District No. V.

<u>Coal Seam</u>	<u>County</u>	<u>Township</u>	<u>Section</u>	<u>Page No.</u>
7	Guernsey	Jackson	--	18
8	Athens	Ames	30	19
	Athens	Bern	28	20
	Athens	Canaan	25	21
	Guernsey	Oxford	8	22
	Morgan	Homer	28	23
9	Noble	Brookfield	3	24
	Noble	Jackson	14,15	25

The techniques used in the chemical analyses are described in these publications:

R. H. Bray. Photometer method for determining available potassium in soils. Dept. of Agron., Agr. Expt. Sta., Ill. Univ. Col. of Agr. Mimeo. Cir. No. AG 1275. Sept. 1945.

Charles Y. Arnold and Touby Kurtz. Photometer method for determining available phosphorus in soils. Depts. of Agron. and Hort., Agr. Expt. Sta., Ill. Univ. Col. of Agr. Mimeo. Cir. No. AG 1306. June 1946.

For soils the readings "High," "Medium," and "Low" indicate the following quantities per acre:

	<u>Low</u>	<u>Medium</u>	<u>High</u>
	- - - - - (Pounds per acre) - - - - -		
Phosphorus	Less than 53	54-75	More than 75
Potassium	Less than 100	100-150	More than 150

NO. 7, UPPER FREEPORT, COAL

GUERNSEY COUNTY

Jackson Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--tan clay loam	1 - 2
Subsoil--dark tan clay; calcareous; pieces of limestone in spots	4 - 6
Sandstone--massive to thin-bedded, dark tan, grading to light gray at bottom	6 - 12
Shale--silty, gray grading to black, somewhat pyritic just over coal; slickensided	4
Coal--No. 7	5

NO. 8, PITTSBURGH, COAL

ATHENS COUNTY

Section 30, Ames Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata :	: of : : strata :	:phosphorus:	:potassium:
	<u>Feet</u>	<u>pH</u>		
Soil--gray silty clay loam; acidic	1	7.1	Low	Low
Clay--gray-green to brown, stiff, plastic, mixed with fragments of limestone; calcareous	2	8.1	Medium	Low
Clay--gray; in places shaly and coaly; calcareous; mixed with limestone fragments (Redstone outcrop ?)	2	8.1	Low	Low
Shale--green, clayey, thin- bedded, soapy; acidic; ex- posed surfaces ferruginous red	8	8.1	Medium	Low
Shale (or clay)--granular, gray with red-purple tinge; calcareous	8	8.1	High	Low
Sandstone--gray, massive, somewhat shaly in lower foot, with occasional limestone nodules	8	8.3	Medium	Low
Shale--gray, silty at top changing gradually to soft clay shale, and then to dark black roof coal; acidic, but <u>not</u> highly acidic	5	3.2	Low	Medium
Coal--No. 8	-	-	-	-

NO. 8, PITTSBURGH, COAL

ATHENS COUNTY

Section 28, Bern Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata :	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--dark brown, silt loam; acidic; friable	2	3.9	Low	Low
Shale--gray to green, fine sand and silty; ferruginous; thick-bedded, medium hardness; upper 3 feet has 2 seams of thin-bedded, gray calcareous sandstone, rather hard. In lower foot of this stratum there is occasionally about a foot of very hard gray limestone.	14	5.8	Medium	Low
Shale--gray to black, very hard, angular, thick-bedded; acidic	14	5.3	High	Low
Coal--No. 8	3	-	-	-

NO. 8, PITTSBURGH, COAL

ATHENS COUNTY

Section 25, Canaan Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray silty clay loam; acidic	$\frac{1}{2}$
Subsoil--red brown sandy clay, mixed with fragments of sandstone; acidic	3
Shale--gray-green, soapy, silty, thin- bedded, mixed with fragments of ferruginous sandstone; acidic; with iron concretions. (Some of shale is fine sand instead of silt.)	10
Shale--gray, thin-bedded, silty, flaky, with lenses and nodules of limestone; acidic	6
Shale--gray, brown mottling, clayey, thin-bedded, soft; highly acid	3
Roof coal--not recovered, with layers of ferruginous, shaly coal; highly acidic	6
Coal--No. 8	-

NO. 8, PITTSBURGH, COAL

GUERNSEY COUNTY

Section 8, Oxford Township

Description of strata (Top to bottom)	:	Thickness (Feet)
Soil--dark brown to black sandy loam	:	1 - 2
Subsoil--tan sandy loam	:	0 - 3
Sandstone--thin-bedded, broken, tan to buff; not massive	:	4 - 12
Shale--olive gray to yellow orange fine sandy silt	:	0 - 4
Shale--reddish-gray, sandy, ferruginous; not definitely striated	:	0 - 4
Shale--light gray to dark gray and black, silty, fairly thick-bedded	:	3 - 7
Coal--No. 8	:	-

NO. 8, PITTSBURGH, COAL

MORGAN COUNTY

Section 28, Homer Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray-brown fine sandy loam	1
Subsoil--light gray to orange tan, sandy to clayey	4 - 5
Sandstone--multi-colored, fragmental to massive, coarse and soft to hard and fine-grained	6 - 15
Shale--gray with ferruginous colorations, sandy, thin-bedded	0 - 4
Shale--gray-green, silty, micaceous, soft	3 - 5
Shale--dark gray to black; soft, silty	1
Coal--No. 8	5
Clay	1
Coal--No. 8	3

NO. 9, SEWICKLEY, COAL

NOBLE COUNTY

Section 3, Brookfield Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--brown clay loam with trace of coal in it	$\frac{1}{2}$ - 1
Subsoil--tan clay	2
Shale--olive to light gray, silty	5
Sand and sandstone	2 - 4
Shale--light gray, sandy, with thin bed of lime rock in it; lime rock is sandy	1
Shale--dark gray grading to black; soft in places and bony in other spots, fissile to nodular	6
Coal--No. 9	3

NO. 9, SEWICKLEY, COAL

NOBLE COUNTY

Sections 14 and 15, Jackson Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--dark brown clay loam	$\frac{1}{2}$
Subsoil--orange-tan clay	$\frac{1}{2}$
Limestone--white, fragmental	1
Clay or silt stone--white, hard, in places somewhat sandy	2
Clay--dark brown, small stones, gravelly	2
Silt stone or sandstone--ferruginous	2
Shale--olive drab, silt and clay	4
Silt stone or sandstone--very light tan, hard	3
Shale--dark gray, very hard	1
Shale and silt stone--light tan to light gray	6
Shale--green, sandy, nodular; sometimes sandstone; micaceous	6
Shale--dark gray to black, silty	1
Coal--No. 9	3 - 4
(High-wall very variable. Sometimes only three strata above coal.)	

APPENDIX II

Descriptions and chemical analyses of strata overlying coal seams in Strip-Mining District No. VI.

<u>Coal Seam</u>	<u>County</u>	<u>Township</u>	<u>Section</u>	<u>Page No.</u>
5	Perry	Clayton	26	27
6	Athens	York	26,27,32	28
	Athens	York	12,18	28
	Athens	York	29	29
	Hocking	Ward	7,8	30
	Hocking	Ward	33,34	30
	Perry	Salt Lick	7	31
	Perry	Jackson	36	31
6a	Athens	York (Area 1)	16	32
	Athens	York (Area 2)	16	33
7	Athens	York	2	34
	Athens	York	6	35
	Athens	Trimble	31	36
	Hocking	Ward	26	36
	Perry	Salt Lick	17	37
	Perry	Monroe	19	37

NO. 5, LOWER KITTANNING, COAL

PERRY COUNTY

Section 26, Clayton Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--brown sandy loam with fragmental sandstone; acidic	3
Soot streak--No. 5a, Strasburg coal	1/6
Clay--red-brown to gray; acidic	4
Sandstone--gray; upper half fragmental, lower half massive, of medium hardness; acidic	24
Shale--gray, clayey; highly acidic	2
Coal--No. 5	-

NO. 6, MIDDLE KITTANNING, COAL

ATHENS COUNTY

Sections 26, 27, and 32, York Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray loam; acidic	$\frac{1}{2}$
Sandy clay loam with pieces of shale becoming more sandy at lower end	5
Shale--gray-green, silty to fine sand; soft, thin-bedded; acidic	12
Sandstone--gray-brown, massive, hard; acidic	16
Shale--gray to gray-blue, thick-bedded, even massive, hard; acidic	12
Coal--No. 6	-

Sections 12 and 18, York Township

Soil--gray loam; acidic	$\frac{1}{2}$
Sandy clay loam--yellow-gray; acidic	6
Sand and fragmental sandstone, mixed with clay from upper stratum; acidic	6
Sandstone--brown, ferruginous, massive, medium hardness; acidic	8
Shale--gray, thick-bedded, ferruginous; carbonaceous (Roof coal)	2
Coal--No. 6	-

NO. 6, MIDDLE KITTANNING, COAL

ATHENS COUNTY

Section 29, York Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray silt loam; acidic	$\frac{1}{2}$	5.3	Low	Low
Clay--gray and yellow sandy clay, mottled red; blocky structure; acidic	12	5.7	Medium	Low
Shale--gray to black, clayey, thin-bedded; acidic	1	6.1	Low	Low
Coal--upper band of No. 6, poor quality, shaly; left on spoils when stripped	1	5.0	Medium	Low
Shale--gray to black, thick- bedded, partly ferruginous; acidic	2	4.5	Low	Low
Coal--No. 6	-	-	-	-

NO. 6, MIDDLE KITTANNING, COAL

HOCKING COUNTY

Sections 7 and 8, Ward Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray-brown loamy sand; acidic	$\frac{1}{2}$
Subsoil--fragmental sandstone; acidic	3
Shale--gray-brown, sandy, thin-bedded, with occasional blocks of sandstone, lower half silty; ferruginous	14
Shale--gray, thin-bedded, silty, rather hard, almost bony; acidic	4
Coal--No. 6	-

Sections 33 and 34, Ward Township

Soil--yellow loamy sand; acidic	$\frac{1}{2}$
Subsoil--yellow sand and fragmental sandstone; acidic	2
Sandstone--yellow-brown, in spots ferruginous, massive, soft, coarse; lower foot highly acidic	18
Shale--gray to black, thin-bedded, rather hard, angular structure, carbonaceous; <u>highly</u> acidic	2
Coal--No. 6	-

NO. 6, MIDDLE KITTANNING, COAL

PERRY COUNTY

Section 7, Salt Lick Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--sandy loam, very thin; acidic	1
Sandstone--fragmental; acidic	6
Sandstone--gray, massive, medium hardness; acidic	4
Shale--gray, clayey, thick-bedded, platy structure	8
Coal--No. 6	-

Section 36, Jackson Township

Soil--gray-brown loamy sand; acidic	$\frac{1}{2}$
Subsoil--brown sandy, with a few fragments of sandstone; acidic	2
Sandstone--gray-brown, in places ferruginous, medium hardness; upper half fragmental, lower half massive; acidic	12
Shale--gray, thin-bedded, upper half silty, lower half soft, clayey; acidic	8
Coal--No. 6	-

NO. 6a, UPPER KITTANNING, COAL

ATHENS COUNTY

Section 16, York Township (Area 1)

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata :	: of : : strata :	:phosphorus:	:potassium:
	<u>Feet</u>	<u>pH</u>		
Soil--gray sandy silt loam; acidic	1	4.9	Low	Low
Clay--gray, mixed with many large boulders and concretions of ferru- ginous limestones; calcareous	1	7.9	Low	Low
Sandstone--gray, massive and fragmental, mixed with sandy shale; micaceous	8	7.5	Low	Low
Limestone--red, ferruginous, or calcareous ore; hard, massive	1	8.2	High	Low
Clay and clayey shale-- gray to red; calcareous, mixed with calcareous pebbles	1	8.3	Medium	Low
Shale--clayey, thin- bedded, carbonaceous, slightly ferruginous; acidic	6	4.2	Medium	Low
Coal--No. 6a	-	-	-	-

NO. 6a, UPPER KITTANNING, COAL

ATHENS COUNTY

Section 16, York Township (Area 2)

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	of	of	phosphorus	potassium
	strata	strata		
	<u>Feet</u>	<u>pH</u>		
Soil--upper 2 inches gray silty clay loam, remainder yellow sandy clay loam	2	5.0	Low	Low
Sandstone--thin-bedded, fragmental, shaly; micaceous; acidic	8	6.4	Low	Low
Shale--gray to black, thin-bedded, clayey, brittle to soft; acidic; carbonaceous	5	4.0	High	Low
Coal--No. 6a	-	-	-	-

NO. 7, UPPER FREEPORT, COAL

ATHENS COUNTY

Section 2, York Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	:phosphorus:	:potassium:
	<u>Feet</u>	<u>pH</u>		
Soil and subsoil--gray to reddish brown silt loam	1 - 2	4.7	Low	Low
Clay--nut-like structure, upper half reddish, lower half yellow-brown; acidic	3	4.3	Low	Low
Sandstone--brown to gray, rather soft, coarse, micaceous; upper half thin-bedded and fragmental, lower half massive; acidic	26	6.1	Low	Low
Shale--gray to black, carbonaceous, flaky, fissile, soft, clayey, thin-bedded but very compact and hard; <u>highly acidic</u>	5	3.0	Medium	Low
Coal--No. 7	4 - 5	-	-	-

NO. 7, UPPER FREEPORT, COAL

ATHENS COUNTY

Section 6, York Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--brown loamy sand; acidic	6	4.5	Low	Low
Shale--gray-green, silty, almost coarse enough to be sand; thick-bedded, mixed with red ferrugi- nous fragments of sand- stone, lower half changing to yellow thin-bedded sand- stone; acidic	8	5.1	Low	Low
Shale--gray, thick-bedded, hard, massive, silty; acidic	10	7.0	High	Low
Coal--No. 7	-	-	-	-

NO. 7, UPPER FREEPORT, COAL

ATHENS COUNTY

Section 31, Trimble Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray silt loam; acidic	$\frac{1}{2}$
Subsoil--gray-brown sandy clay loam	2
Shale--gray-green, thin-bedded, silty, brittle; acidic	12
Shale--gray-green, mottled red, thick- bedded, silty, ferruginous, rather hard; acidic (sandstone in some places)	10
Shale--gray-black, thin-bedded, flaky, silty; <u>highly</u> acidic	$1\frac{1}{8}$
Coal--No. 7	-

HOCKING COUNTY

Section 26, Ward Township

Soil--gray-brown loamy sand; acidic	$\frac{1}{2}$
Subsoil--fragmental sandstone; acidic	2
Sandstone--brown, massive; acidic	10
Shale--gray, thick-bedded, coarse (almost sandy) slightly ferrugi- nous, becoming soft and more silty at lower end; acidic	24
Coal--No. 7	-

NO. 7, UPPER FREEPORT, COAL

PERRY COUNTY

Section 17, Salt Lick Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil and subsoil--sandy	2
Sandstone--massive, very soft; upper half brown, lower half chalky white; acidic	20
Shale--gray, silty, thin-bedded; highly acid	-
Coal--just a narrow band, not recovered in mining	1
Clay--shaly, soft; highly acidic	5+
Talus	2
Coal--No. 7	-

Section 19, Monroe Township

Soil--gray silt loam; acidic	1
Subsoil--brown silty clay; acidic	2
Clay--gray, plastic, granular structure; acidic	8
Shale--olive green, thick-bedded, clayey; acidic	4
Shale--gray, compact, thinly laminated, clayey; acidic	10
Coal--No. 7	-

APPENDIX III

Descriptions and chemical analyses of strata overlying coal seams in Strip-Mining District No. VII.

<u>County</u>	<u>Coal Seam</u>	<u>Township</u>	<u>Section</u>	<u>Page No.</u>
Jackson	1	Liberty	15	39
	2	Milton	31	40
	4a	Madison	31	41
	4a	Milton	20	42
	5	Franklin	25	43
	5	Jefferson	2	43
	5	Jefferson	12	44
	5	Madison	31	45
	5+clay	Madison	19	46
	7	Milton	13,24	47
Vinton	4	Elk	17	48
	Ogan	Elk	17	49
	4a	Elk	26	50
	4a	Swan	12	51
	4a	Swan	26	52
	4a+limestone	Wilkesville	28	52
	6	Clinton	15	53
	7	Wilkesville	32	54
	7	Wilkesville	33	55

JACKSON COUNTY

NO. 1, SHARON, COAL

Section 15, Liberty Township

Description of strata (Top to bottom)	:Thickness:	Acidity:	Available	Available
	: of : : strata :	of : : strata :	:phosphorus:	:potassium:
	<u>Feet</u>	<u>pH</u>		
Soil--gray loam; acidic	1	5.3	Low	Low
Sandstone--brown, thin-bedded but hard, somewhat ferruginous, and mixed with sandy soil; acidic	6	5.9	Medium	Low
Shale--gray-blue, thick-bedded, silty (sometimes fine sand) very hard, bony; calcareous; very slightly ferruginous	20	7.2	Medium	Low
Clay--gray-black, soft; acidic. Near its top is a $\frac{1}{2}$ -inch band of calcareous sandstone; in middle is 2-inch band of coal	1	6.4	High	Low
Coal--No. 1	-	-	-	-

JACKSON COUNTY

NO. 2, QUAKERTOWN, COAL

Section 31, T. 9 N., Milton Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata :	: of : : strata :	: phosphorus :	: potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--dark brown, sandy clay loam; acidic	1/3	5.0	Low	Medium
Subsoil--red-brown to gray clay, stiff, plastic, but mixed with small amount of sandy shale or sand- stone fragments; acidic	4	5.1	Low	Low
Sandstone--gray to brown, massive, ferruginous; acidic	8	6.1	Low	Low
Shale--blue-gray, hard, bony, thick-bedded, breaking up into "flakes"	20	5.4	High	Low
Water	-	-	-	-
Coal--No. 2	-	-	-	-

JACKSON COUNTY

NO. 4a, CLARION, COAL

Section 31, Madison Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	: phosphorus :	: potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--gray, silt loam; acidic	$\frac{1}{2}$	5.7	Low	Low
Subsoil--sandy clay, mixed with fragments of sandstone; acidic	2	5.1	Low	Medium
Sandstone--brown, hard, massive, mixed with iron concretions; acidic	16	5.7	Low	Low
Shale--gray, clayey (in fact, nearly all clay), soft, blocky, ferruginous, mixed with iron nodules; acidic	8	5.7	High	Low
Limestone--gray, hard, mixed with ferriferous ores, somewhat massive	1	6.4	Low	Low
Shale--gray, blocky, hard, clayey	2	7.0	Low	Medium
Coal--No. 4a	-	-	-	-

JACKSON COUNTY

NO. 4a, CLARION, COAL

Section 20, Milton Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--brown silty clay; acidic	1/2
Subsoil--gray, clay, plastic; acidic	-
Sandstone--gray, soft, massive; easily crumbled with fingers; somewhat harder and more ferrugi- nous in lower foot; acidic	8
Limestone--gray to brown, very hard, ferruginous, massive, fossiliferous	2 - 4
Clay--gray, but somewhat brown because of considerable iron in it; calcareous	2
Coal--No. 4a (Mixed with it are bands of highly acid clay)	4

JACKSON COUNTY

NO. 5, LOWER KITTANNING, COAL

Section 25, Franklin Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--brown, silty clay; acidic	1
Clay--gray to brown mottled, sticky, plastic; mixed with fragments of a fine sand or silt stone	6
Clay--gray, sticky, plastic; acidic	4
Shale--gray to black, red and yellow mottling, carbonaceous; mixed with considerable quantities of iron nodules and concretions; ferruginous, carbonaceous, thin-bedded, silty to clayey; acidic	12
Coal--No. 5	-

Section 2, Jefferson Township

Soil--gray sandy loam; acidic	1/2
Subsoil--sandy clay loam; acidic	2
Sandstone--gray, fragmental, shaly, ferruginous; acidic	4
Shale--gray with red mottling, silty, hard, ferruginous, thin-bedded; acidic	5
Shale--gray to black, slaty, silty, carbonaceous, ferruginous in spots; acidic	2
Coal--No. 5	-

JACKSON COUNTY

NO. 5, LOWER KITTANNING, COAL

Section 12, Jefferson Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray silty clay loam; acidic	1/2
Subsoil--yellow, clay, plastic; changing to sand on lower foot; acidic	4
Sandstone--gray, massive, ferruginous, very soft, crumbles when shovel moves it	10
Shale--gray, clayey, blocky structure, changing to clay in portions of wall; acidic	-
Clay (or shale)--gray to red, thick-bedded, ferruginous; mixed with large iron con- cretions; acidic	10
Shale--gray to red, hard, slaty, silty	2
Coal--No. 5	3

JACKSON COUNTY

NO. 5, LOWER KITTANNING, COAL

Section 31, Madison Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	: phosphorus :	: potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--gray sandy loam; acidic	1	5.2	Low	Low
Subsoil--brown sand; acidic	3	4.8	Low	Low
Sandstone--brown, very soft, massive; acidic	6	4.6	Low	Low
Clay--gray, brown mottling, plastic, ferruginous; acidic	4	4.2	Low	Low
Shale--silty and clayey, thin-bedded; lower portion slightly fossiliferous; all parts ferruginous in spots; acidic	8	4.3	High	Low
Shale--gray, silty, a little carbonaceous, fossiliferous, hard; acidic	1	3.9	High	Low
Coal--No. 5	-	-	-	-

JACKSON COUNTY

NO. 5, LOWER KITTANNING, COAL

Section 19, Madison Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray silty clay loam	1/3
Subsoil--brown silty clay, with some hard clay intermixed; acidic	2
Clay--gray, hard, massive, ferrugi- nous; acidic	12
Sandstone--red-brown, massive, hard, of fine sandy material, ferruginous; acidic	5
Shale--gray to red, very ferruginous, thick-bedded, hard; lower half more thin-bedded; clayey to silty; acidic with large iron ore boulders	12
Coal--No. 5	4
Clay--gray, plastic	4

JACKSON COUNTY

NO. 7, UPPER FREEPORT, COAL

Sections 13 and 24, Milton Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray silt loam; acidic	1/2
Subsoil--brown sandy loam, mixed with considerable sand and fragmental sandstone; acidic	4
Sandstone--brown; usually very soft, but hard and ferruginous in spots; massive; acidic	12
Shale--silty, soft, gray-green, thin- bedded, slightly ferruginous; acidic	20
Ore--very hard; interior grayish, exterior reddish; acidic	3
Shale (roof coal)--fissile, silty; <u>highly</u> acidic	1
Coal--No. 7	-

VINTON COUNTY

NO. 4, BROOKVILLE, COAL

Section 17, Elk Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	: phosphorus :	: potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--brown sandy loam; acidic	$\frac{1}{2}$	4.8	High	Low
Subsoil--yellow sandy clay, red mottling, ferruginous; acidic	5	5.2	Low	Low
Shale--gray-green, clayey, soft, thick- bedded; portions of it ferruginous; acidic	6	6.9	High	Low
Shale--gray, clayey, thick-bedded, hard; calcareous	14	7.3	Medium	Low
Coal--No. 4	-	-	-	-

VINTON COUNTY

OGAN COAL

Section 17, Elk Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	: phosphorus :	: potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--gray-brown loamy sand	$\frac{1}{2}$	5.6	Medium	Low
Subsoil--yellow- brown sand, mixed with very soft sandstone pebbles	4	5.2	Low	Low
Sandstone--gray to brown, coarse, massive and fragmental, soft, slightly ferruginous; acidic	10	5.2	Low	Low
Shale--gray to black, silty, thick-bedded; acidic; mixed with calcareous boulders	8	6.0	High	Low
Coal--Ogan	-	-	-	-

VINTON COUNTY

NO. 4a, CLARION, COAL

Section 26, Elk Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	: phosphorus :	: potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--stony sandy loam; acidic	$\frac{1}{2}$	4.6	Low	Low
Shale--gray to brown, sandy, ferruginous, thin- bedded, mixed with sand, in places changing to thin-bedded sandstone; acidic	6	4.0	Medium	Low
Sandstone--brown, massive and fragmental, ferruginous and slightly micaceous; acidic	5	5.1	Low	Low
Shale--gray to black, clayey, nut-like structure, carbonaceous, sooty (may be outcrop of a coal seam, No. 5); acidic	6	4.0	Low	Medium
Sandstone--gray, crystalline; some pieces very ferruginous; massive; acidic	-	4.7	Low	Low
Shale--gray, clayey, fossili- ferous; calcareous; mixed with very hard calcareous ores	12	6.9	High	Low
Shale--clayey, parts ferruginous, parts carbonaceous, highly acidic	1	2.9	Low	High
Coal--No. 4a	-	-	-	-

VINTON COUNTY

NO. 4a, CLARION, COAL

Section 12, Swan Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray sandy loam; acidic	1/2
Subsoil--brown sand; acidic	6
Sandstone--gray mottled brown, soft, ferruginous; acidic	-
Shale--gray, thick-bedded, hard, car- bonaceous, ferruginous; acidic	3
Coal--good, unidentified	1/2
Shale--gray, thick-bedded, hard, ferruginous; acidic	10
Coal--No. 4a	-

VINTON COUNTY

NO. 4a, CLARION, COAL

Section 26, Swan Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray silty loam; acidic	1
Subsoil--brown sandy loam	2
Silt or very fine sand, yellow-brown; acidic	3
Sandstone--gray to brown, very soft, massive; acidic	8
Sandstone--reddish, hard, ferruginous; acidic	2
Shale--gray, red mottling, thin-bedded and thick-bedded, medium hardness; ferruginous, with iron concretions; acidic	4
Clay--gray, soft, rotten; highly acidic	1/2
Coal--No. 4a	-

Section 28, Wilkesville Township

Soil--gray silt loam; acidic	1
Sandstone--gray, fragmental mixed with sand and clay; acidic	3
Clay--gray, shaly with some iron concretions; very hard, massive; acidic. (May be shale.)	12
Limestone--gray, very hard, ferruginous, fossiliferous	6
Talus	2
Coal--No. 4a	-

VINTON COUNTY

NO. 6, MIDDLE KITTANNING, COAL

Section 15, Clinton Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata :	: of : : strata :	: phosphorus :	: potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--dark gray-brown, silt loam; acidic	$\frac{1}{2}$	5.3	Low	Low
Subsoil--brown, sand to sandy loam; mixed with fragmental sandstone	3	5.0	Low	Low
Clay--gray to black, sooty, carbonaceous (probably position of 6a coal seam); acidic	1 - 2	4.6	Low	Low
Shale--gray-green, thin- bedded, silty, upper foot somewhat sandy, micaceous; acidic	4	5.0	Low	Low
Shale--gray-green, soft thin-bedded, silty; acidic; lower portion with thin band of sandy micaceous shale, and below that occasional areas of shaly coal and highly acidic clay	14	3.0	Medium	Low
Shale--gray-black, thin- bedded, mixed with nodular limestone and calcareous ores and concretions; acidic	8	5.9	High	High
Coal--No. 6	-	-	-	-

VINTON COUNTY

NO. 7, UPPER FREEPORT, COAL

Section 32, Wilkesville Township

Description of strata (Top to bottom)	Thickness (Feet)
Soil--gray-brown silty clay loam; acidic	1/2
Subsoil--reddish clay, mottled gray; acidic	5
Sandstone--gray-brown, very hard, ferruginous, micaceous, massive; acidic	8
Shale--gray-brown, sandy, thin-bedded and thick-bedded, micaceous; acidic	14
Shale--gray, thin-bedded, coarse silt (almost sandy); partly thick-bedded, flaky. Thick-bedded shale is ferruginous.	8
Coal--No. 7	-

VINTON COUNTY

NO. 7, UPPER FREEPORT, COAL

Section 33, Wilkesville Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	of strata	of strata	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--brown sandy loam; acidic	$\frac{1}{2}$	5.1	Low	Low
Shale--gray-green, thin- bedded, soft, mixed with fragments of hard, thick- bedded, ferruginous shale, almost coarse enough to be sandstone; lower foot thick-bedded	10 - 16	5.4	Low	Low
Shale--gray-black, clayey, soft, grading almost to clay in lower foot; acidic	5	6.8	Low	Low
Shale--silty, hard, ferruginous, ore-like, gray, mottled orange	1	3.9	Low	Low
Coal--No. 7	3	-	-	-
(Note--some parts of high-wall have massive sandstone just below soil.)				

APPENDIX IV

Descriptions and chemical analyses of strata overlying coal seams in Strip-Mining District No. VIII.

<u>County</u>	<u>Coal Seam</u>	<u>Township</u>	<u>Section</u>	<u>Page No.</u>
Gallia	7	Walnut	19	57
	8	Guyan	12	58
Lawrence	8a	Mason	2	59
Meigs	8	Bedford	29	60
	8a	Salisbury	16	61

GALLIA COUNTY

NO. 7, UPPER FREEPORT, COAL

Section 19, Walnut Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	: phosphorus :	: potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--gray sandy loam; acidic	1	4.8	Low	Low
Sand--brown, mixed with occasional fragments of sandstone; ferruginous in streaks	14	4.8	Low	Low
Sandstone--hard, but sand easily rubs off, ferruginous, massive; acidic	6	3.7	Medium	Low
Shale--very soft, clayey; highly acidic	3	2.4	Medium	High
Talus	2	-	-	-
Coal--No. 7	-	-	-	-

GALLIA COUNTY

NO. 8, PITTSBURGH, COAL

Section 12, Guyan Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata :	: of : : strata :	: phosphorus :	: potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--dark brown silty clay loam; acidic	1	4.6	Low	Low
Subsoil--brown sandy clay loam, mixed with fragmental sandstone at lower end; acidic	-	3.9	Low	Low
Sandstone--gray and brown. Brown stone is micaceous, ferruginous; acidic. Gray stone is calcareous. Both very hard and mixed with calcareous ores. Mostly massive.	8	7.0	Low	Low
Shale--clayey, soft, blocky; calcareous; mixed with acidic ores	8	7.5	Low	Low
Shale--gray to gray-green, silty, hard, thin-bedded; mixed with calcareous ores; acidic	12	7.9	Low	Low
Shale--gray, thin-bedded, flaky, ferruginous; mixed with calcareous ores and nodular limestone; acidic	3	5.7	Low	Medium
Shale--ferruginous, soft, red-brown; lower part hard slaty roof coal; highly acidic	2	5.4	Medium	Low
Coal--No. 8	-	-	-	-

LAWRENCE COUNTY

NO. 8a, POMEROY, COAL

Section 2, Mason Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	: Available : : phosphorus :	: Available : : potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--gray silty clay loam; acidic	1	5.3	Low	Low
Subsoil--reddish-yellow sandy clay, blocky structure; acidic	3	5.0	Low	Low
Sandstone--gray-brown, somewhat massive; acidic	4	5.4	Low	Low
Shale--gray-green, hard, silty, thin-bedded, mixed with very hard fragmental sandstone; shales ferrugi- nous; acidic	14	4.6	Medium	Low
Alternate narrow bands of hard sandstone and thin- bedded silty shale, both highly acidic	2	3.0	Medium	High
Coal--No. 8a	-	-	-	-

MEIGS COUNTY

NO. 8, PITTSBURGH, COAL

Section 29, Bedford Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	of	of	phosphorus	potassium
	strata	strata		
	<u>Feet</u>	<u>pH</u>		
Soil--gray sandy loam; acidic	$\frac{1}{2}$	3.5	Low	Low
Subsoil--brown sandy clay loam; acidic	4	3.5	Medium	Low
Gray to brown sandy clay, mixed with ferruginous shale and fragments of sandstone; acidic	1	4.4	Low	Low
Clay--gray, plastic, mixed with ferruginous shale fragments and iron concretions; acidic	8	5.8	Low	Low
Shale--gray, clayey, very soft, thin-bedded, mixed with few limestone boulders; acidic	8	6.9	Medium	Low
Coal--No. 8	-	-	-	-

MEIGS COUNTY

NO. 8a, POMEROY, COAL

Section 16, Salisbury Township

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : : strata : strata :	: of : : strata : strata :	: phosphorus : : strata : strata :	: potassium : : strata : strata :
	<u>Feet</u>	<u>pH</u>		
Soil--brown sandy loam; acidic	$\frac{1}{2}$	5.1	Low	Low
Sandstone--gray-brown; upper foot fragmental, remainder massive, soft, coarse-grained; acidic	10	5.1	Low	Low
Shale--gray to black, thick-bedded, soft, silty and clayey, ferruginous; acidic	10	4.7	Low	Low
Sandstone--shiny gray, hard; acidic	$\frac{1}{4}$	2.7	Medium	Low
Shale--gray, hard, thin- bedded, bony, fossiliferous, mixed with small fossili- ferous limestone nodules; acidic	6	3.7	High	Low
Coal--No. 8a	-	-	-	-

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